IEEE SoutheastCon 2023 Hardware Competition

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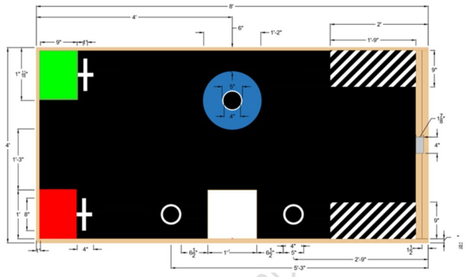
Executive Summary

The goal of this project was to design and fabricate an autonomous robot to compete in the 2023 IEEE SoutheastCon Hardware Competition. The finalized design needed to both complete specified objectives and comply with constraints outlined in a set of rules and regulations provided by the competition organizers. The completed robot placed 4th overall out of 36 registered teams.

Competition Gameplay

The theme for the 2023 IEEE SoutheastCon Hardware Competition centered around autonomous cleanup of “Duck Gardens” following a natural disaster. The competition outlined numerous objectives relating to object manipulation which teams could choose to complete for varying point values. The primary constraints for the robot were as follows: the robot must fit within a cubic foot at the beginning of each run, operate entirely autonomously, and complete each run within 3 minutes.



Areas in Competition Arena	
White Square	Starting Zone
Green Zone	Feeding Area
Red Zone	Feeding Area
Blue Circle	Duck Pond
Striped Zones	Recycling Areas

FIGURE 1: Competition Arena and Labeled Zones

Objective	Points
3 pedestals stacked on a non-pond statue location inside the outer circle and in any order	18
2 pedestals stacked on a non-pond statue location inside the outer circle and in any order	12
Start Fireworks (flip switch)	10
Auto Start (detect red laser)	10
Food Chip in Correct Zone	7
Food Chip in Incorrect Zone	3
Duck in Pond	5
Game Piece Inside Recycling Zone	2

FIGURE 2: Primary Gameplay Objectives

Design Considerations

Of the many objectives outlined in the competition rules, the team chose a more limited subset to increase consistency. This scope was analyzed and changed throughout the design process to maintain a robust system going into the competition. The finalized scope included depositing feeding chips into the correct colored areas and pushing all game pieces into the designated recycling areas.

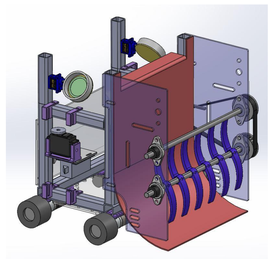
Competition Video

GitHub Repository

Left to Right: Mark Beech, Madison Kelly, Luke McGill, Nathan Gardner, Carlos Salvatierra, Grayson Vermillion, Ethan Lewis

Design

- **Chip Feeding:** Delivered red/green poker chips to matching feeding areas using a rotating storage on servo motors
- **Locomotion:** Mecanum wheels were used to traverse the arena for higher range of motion.
- **Power:** Powered every system with two 6 V batteries and a 12 V battery.
- **Low-level Controller:** Arduino Mega was selected as the main motor controller.
- **Top-level Controller:** Nvidia Jetson selected for computation power as compared to Raspberry Pi.
- **Delivery System:** Repurposed intake to push objects into recycling zones
- **Software:** Robot Operating System (roscpp and rospy) were used for message passing between the Nvidia Jetson and Mega2560.



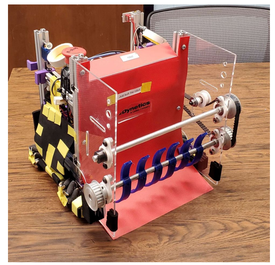


FIGURE 3: Finalized CAD Design and Fabricated Assembly

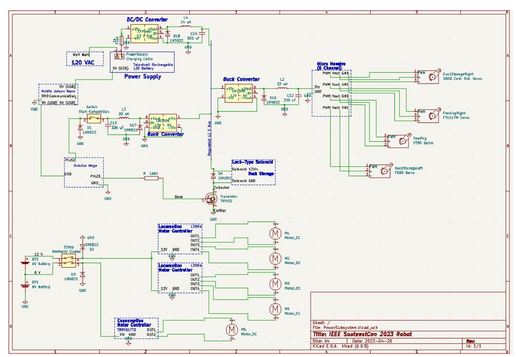


FIGURE 4: Electrical Schematic

Experimental Analysis

Round	Green chip	Red chip	Cylinder Recycle	Duck Recycle	Duck Pond
1	3	3	1	4	0
2	3	3	0	0	0
3	2	3	0	0	0
4	2	2	4	6	0
5	3	3	4	1	0
6	2	2	1	2	1

Round	Point Total
1	52
2	42
3	35
4	48
5	52
6	39

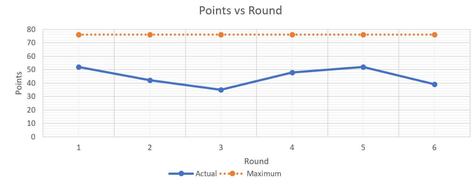


FIGURE 5: Experimental Data from All Competition Runs

The above data was collected from runs during the competition and shows how points were gained in each round of the competition. The dotted line shows the value of points targeted if the team had reached all goals listed after the rescoped discussed in Design Considerations.

Focusing on fundamentals, i.e. filtering out the noise of all that could be done to gain points and being able to deliver food chips consistently in the first three rounds, is what the team feels got us to the semi-finals. This is also what won the team the first game of the semi-finals against Mississippi State.

Improvements and Reflection

Based on our experimentation and observing our competitors at the competition, especially in the last two rounds, the team would have addressed some issues differently. Namely, the food chip feeders could have been lowered on the chassis of the robot to more consistently place chips in the feeding area. Another feature that could have been implemented to get more points was the automatic LED start function outlined in the competition rules. With more time to adjust the path and run tests at the competition, the team also thinks the number of items that ended up in the recycling area after each round could have increased.

These improvements if implemented in time could have made the difference in the semi-finals and could have allowed the team to qualify for the finals match at the awards banquet, gaining first or second in the competition.

Project Expenses

Purchase	Cost
Power	$236.81
Duck Storage	$234.88
Feeding	$10.50
Pedestal Storage and Delivery	$35.85
Sorting	$100.04
Low-Level Controller	$106.79
Locomotion	$262.29

Purchase	Cost
Top-Level Controller	$231.95
Vision	$141.49
Consumption	$306.43
Chassis	$753.78
Arena Build	$269.28
Miscellaneous	$126.96
Total Cost	**$2,690.09**

FIGURE 6: Generalized Table for All Project Expenses

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